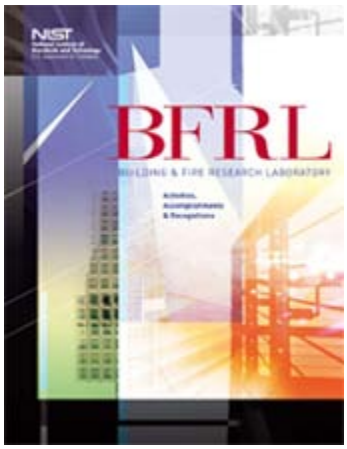
BFRL News

Building and Fire Research Laboratory

National Institute of Standards and Technology • U.S. Department of Commerce

April 2010

At BFRL, we are continually looking to engage our stakeholders, both here and abroad, working to build and strengthen our relationships with them. A new workshop report from the National Research Council (NRC) lends credence to our approach. The report identifies five key activities to advance the competitiveness and effectiveness of the nation's construction industry that employs millions of workers and affects home prices, consumer goods and the national economy. The report recommends NIST work with industry leaders to develop a collaborative strategy to implement and deploy the five activities with potential for breakthrough improvements: interoperable technology solutions, job-site efficiencies, off-site fabrication processes, field testing and demonstrations, and effective performance metrics. The report also recommends that NIST should take the lead in developing a "technology readiness index" similar to those used by NASA and the Department of Defense to assess the readiness for deployment of high-risk, high-cost, high-impact innovations. In addition, the report recommends that NIST work with government agencies and construction industry groups to develop effective measures for tracking productivity and to enable improved efficiency and competitiveness.



BFRL Activities , Accomplishments, and Recognitions, January 2010

Our relationship with the U.S. Nuclear Regulatory Commission (NRC) has been growing over the last few years. We recently hosted NRC Chairman Gregory Jaczko for a tour of our Large Fire Laboratory to witness experiments sponsored by NRC through a multi-year collaborative program. This collaborative arrangement has been in place for a while and is expanding now. Also, Dr. Jaczko introduced an NRC-hosted talk on our WTC 7 investigation, which coincided with this year's 9/11 anniversary. In his opening statement, Dr. Jackzo emphasized the close working relationship we enjoy. He also described the benefit that NIST's ongoing research on fire and the vulnerabilities of aging structures can have on the NRC in its role as overseer of the safety and security of the Nation's nuclear power facilities.

We are also reaching out internationally. BFRL senior management visited the Centre Scientifique et Technique du Batiment (CSTB) laboratories in Paris and Nantes in November 2009 to discuss a strategic partnership. BFRL/NIST and CSTB have identified a broad spectrum of research activities with the potential of achieving improved design and construction practices through bilateral cooperation. These discussions and the November 2009 visit built on the NIST-

ARRA-Funded Facilities at NIST

NIST has received Congressional approval on its recovery plan to create jobs, strengthen the economy and encourage innovation. Under the American Recovery and Reinvestment Act (ARRA), NIST was granted $580 million in direct appropriations, along with an additional $30 million transferred to NIST from other federal agencies, to invest in construction projects, grants, scientific equipment, and research fellowships.

Among the projects that is being funded through this Act are the design and construction of a $22 million National Structural Fire Resistance Laboratory (NSFRL), that will enable NIST to develop the capability to test structures under realistic fire and structural loading; develop an experimental database on performance of large-scale structural connections, components, subassemblies, and systems under realistic fire and loading; develop validated physics-based models to predict the fire resistance performance of structures; and develop the technical basis for performance-based standards for use in the fire resistance design of structures. Construction of the facility is expected to be completed in 2012.

NIST also is building a $2 million Net-Zero Energy Residential Test Facility. The facility, similar in appearance to conventional homes found in surrounding communities, will be used to demonstrate that a house can

CSTB four 5-year Joint Agreements that commenced in 1969 and continued through the 1970s and 1980s. The objective of the envisioned research cooperation is to advance building technology, stimulate ideas for innovations, and exchange information about on-going and completed research. This includes initiating joint research projects, exchanging guest researchers, and sharing data and information about building technology with the potential of improving the quality of life of citizens from both countries.

In addition, we've recently published a 104-page report on BFRL Activities, Accomplishments, and Recognitions. This report provides details of BFRL's research activities and the impacts of our results, which often include changes to building and fire safety standards and codes. This report can be found on the BFRL website (http://www.nist.govbfrl/.)

So, you can see that the Laboratory has been busy building and maintaining strategic partnerships in order to better fulfill our mission to promote U.S. innovation and competitiveness by anticipating and meeting the measurement science, standards, and technology needs of the U.S. building and fire safety industries in ways that enhance economic security and improve the quality of life.

Sincerely,
Dr. S. Shyam Sunder
Director, Building and Fire Research Laboratory

Publication Offers Constructive Advice for Construction Industry Efficiency

A new workshop report from the National Research Council (NRC) identifies five key activities to advance the competitiveness and effectiveness of the nation's construction industry that employs millions of workers and affects home prices, consumer goods and the national economy.

Advancing the Competitiveness and Efficiency of the U.S. Construction Industry

The workshop commissioned by the National Institute of Standards and Technology (NIST) gathered industry experts to identify and prioritize technologies, processes and technology deployment activities that have the greatest potential to advance the U.S. construction industry's capital facilities sector, which includes commercial, industrial and infrastructure projects. The resulting report, *Advancing the Competitiveness and Efficiency of the U.S. Construction Industry*, identifies five interrelated activities that could lead to breakthrough improvement in the quality, timeliness, cost-effectiveness, and sustainability of construction projects.

The five key activities listed in the NRC report are: widespread deployment and use of Building Information Modeling; improved job site efficiency through more effective interfacing of people, processes, materials, equipment and information; greater use of prefabrication, preassembly, modularization and off-site fabrication techniques and processes; innovative, widespread use of construction demonstration installations; and effective performance measurement tools to drive efficiency and support. The report recommends NIST work with industry leaders to develop a collaborative strategy to implement and deploy the five NRC activities and to establish a "technology readiness index" similar to those of NASA and the Department of Defense to verify a new process's readiness for deployment. It also recommends that NIST work with government agencies and construction

produce as much energy as it consumes on an annual basis. It will incorporate green building technologies such as an advanced enclosure system, integrated mechanical comfort and ventilation systems, advanced control technologies, and both solar photovoltaic and solar thermal systems. The facility also will serve as a test-bed for in-situ performance measurements, to quantify energy-use reductions through embedded intelligence in building control systems, and to compare actual installed performance to controlled laboratory measurements. Construction of the facility is expected to be completed in 2011.

BFRL's Ed Garboczi Named NIST Fellow

BFRL's Ed Garboczi became a NIST Fellow effective April 26, 2009. He joins a highly distinguished group of 30 scientists and engineers from the roughly 1,500 across NIST. This group includes BFRL's Emil Simiu and Dick Gann (who holds an equivalent position).

Since joining NIST in October of 1988, Ed has applied his expertise in theoretical and computational condensed matter physics to pioneer the Computational Materials Science (CMS) of concrete and has used this science to solve some of the most pressing problems in concrete. In the process, he has greatly advanced the CMS of composite materials in general. Under his leadership, the BFRL concrete materials research program has become world-class, and his CMS research has reinvigorated fundamental research in the materials science research of concrete, has established a close mutually beneficial partnership with industry and academia, and has provided new insight into long-standing industrial problems.

Before Ed came to NIST, there was no materials science theory for concrete, and therefore no

industry groups to develop effective measures for tracking productivity and to enable improved efficiency and competitiveness.

NIST economists have already published a blueprint for industry change called Metrics and Tools for Measuring Construction Productivity: Technical and Empirical Considerations. (See "*Blueprint for Industry Change Aims to Improve Construction Productivity*", NIST Tech Beat, Oct. 20, 2009.)

NIST Releases Final Report on Cowboys Facility Collapse

The National Institute of Standards and Technology (NIST) has released its final report on the May 2, 2009, collapse during a severe thunderstorm of the fabric-covered, steel frame practice facility owned by the National Football League's Dallas Cowboys. The final report is strengthened by clarifications and supplemental text based on comments provided by organizations and individuals in response to the draft report on the collapse, released for public comment on Oct. 6, 2009. The revisions did not alter the study teams main finding: the structure collapsed under wind loads significantly less than those required under applicable design standards.

Overall view of collapsed structure after fabric had been removed. (Photo Credit: NIST)

Also left unchanged after the comment period is NISTs recommendation that other fabric-covered frame structures be evaluated to ensure adequate performance under design wind loads. These evaluations, says NIST, should determine whether or not the fabric covering provides lateral bracing for structural frames considering its susceptibility for tearing; whether the building should be considered partially enclosed or fully enclosed based on the openings that may be present around the buildings perimeter; and whether the failure of one or a few frame members may propagate, leading to a partial or total collapse of the structure.

Based on data acquired during a reconnaissance of the collapsed facility, NIST developed a two-dimensional computer model of a typical structural frame and then analyzed that frame to study its performance under various wind conditions. NIST worked with the National Oceanic and Atmospheric Administration's (NOAA) National Severe Storms Laboratory to estimate the wind conditions at the time of collapse. The researchers determined that, at the time of collapse, the wind was blowing perpendicular to the long side of the building. Maximum wind speed gusts at the time of collapse were estimated to be in the range of 55 to 65 miles per hour, well below the design wind speed of 90 miles per hour as specified in the national standard for wind loads.

NIST and NOAA analyzed the available wind data and concluded that a microburst (a small, intense downdraft which results in a localized area of strong winds) was centered about one mile southwest of the structure at the time of collapse. The wind field in the vicinity of the structure was predominately lateral, as assumed in design.

interaction of materials science experiment and theory. Now, because of his efforts, a vigorous, internationally recognized CMS of concrete exists that strongly drives increasingly sophisticated experiments worldwide.

Recent Recognitions

DOC Silver Medal A. Hunter Fanney, Piotr A. Domanski, William M. Healy, David A. Yashar, W. Vance Payne, Brian P. Dougherty, W. Stuart Dols, Steven J. Nabinger, Stephen J. Treado, and Natascha S. Castro, for the development of appliance test procedures that form the basis of the U.S. appliance energy labeling program.

DOC Silver Medal Edward J. Garboczi, Dale P. Bentz, Jeffrey W. Bullard, and Nicos Martys for providing industry a scientifically-based prediction tool that supports the transformation of standards and specifications from prescriptive to performance-based for concrete.

NIST Bronze Medal Dale P. Bentz and Kenneth A. Snyder, for outstanding research leading to the discovery of and patent application for the VERDiCT -- doubling of concrete service life technology.

NIST Bronze Medal Christopher C. White, for outstanding scientific and engineering contributions to the Sealants Service Life Prediction Consortium.

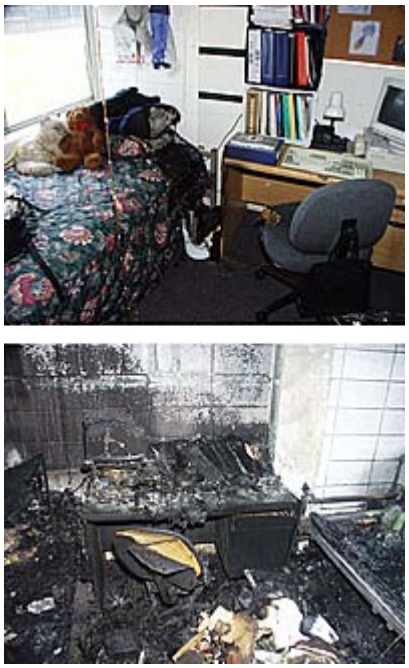
Jacob Rabinow Applied Research Award Jeffrey W. Gilman, for a pioneering role in enabling a new class of fire retardant material-clay nanocomposites.

Edward Bennett Rosa Award Steven T. Bushby, for outstanding technical work and leadership in developing standards for computerized building energy management and control systems.

NIST is working with various public and private groups toward implementing changes to practice, standards, and building codes based on the findings from this study. The complete text of the final report may be accessed at http://www.nist.gov/bfrl/investigations/bfrl-investigations.cfm.

Smoke Alarms + Sprinklers + Closed Doors = Lives Saved in Dorm Fires

Experimenting on a university dormitory that was scheduled to be torn down, fire researchers from the National Institute of Standards and Technology (NIST) have demonstrated that the correct combination of automatic fire sprinkler systems, smoke alarms and closed doors provided enough time and safe conditions for residents to escape safely and for firefighters to perform their job without undue hazard. The study's goal was to compare the hazard levels created by room fires in dormitory buildings with and without sprinklers in the room where the fire starts. Researchers used a dorm at the University of Arkansas in Fayetteville, Ark., that was scheduled to be replaced with a high-rise building.



These post-fire photographs of the dorm rooms show the difference a sprinkler makes. There is little visible damage the in the top photo that had a sprinkler in the room; there was no sprinkler in the dorm room in the lower picture. (Photo Credit: NIST)

The five rooms used in the experiment were furnished as typical dorms are and included clothing, books and furniture. Smoke alarms were installed in the rooms and the corridors. The smoke alarms activated within 30 seconds of ignition of a trash container in a dorm room. Experiments 1 and 2 were conducted with the dorm room door and windows closed and in both the experiments the corridor remained tenable, which would allow other students to exit safely past the room. Rooms for experiments 2 and 3 had automatic fire sprinklers installed. The automatic fire sprinklers activated within two minutes after ignition in both experiments. In the sprinklered experiments, tenability was maintained in the dorm room and the corridor. Experiments 4 and 5 were conducted with the door of the dorm room open and no active sprinkler. In both experiments the tenability limits were exceeded in the dorm room and corridor.

"This study demonstrated the value of balanced fire safety design," says NIST Fire Protection Engineer Dan Madrzykowski. "The results show the potential life safety benefits of smoke alarms, compartmentation and automatic fire sprinkler systems in college dormitories and similar occupancies." The experiments also demonstrated the importance of a closed door between the fire room and corridor in limiting the spread of smoke and gasses to other areas of the building.

The studied was performed as part of the U.S. Fire Administration's initiative to improve fire safety in college housing and in collaboration with the University of Arkansas and the Fayetteville Fire Department. Another series of experiments

Focus on Recruiting

BFRL is actively recruiting at all levels in many key areas (e.g., Disaster and Failure Studies, Simulation & Analysis of Building Mechanical Equipment and Controls, Photovoltaic Module/System Measurement Science, Information Systems Integration, Characterization of Indoor Contaminant Exposure, Building Energy Standards). For more details, please visit the BFRL Career Web Site.

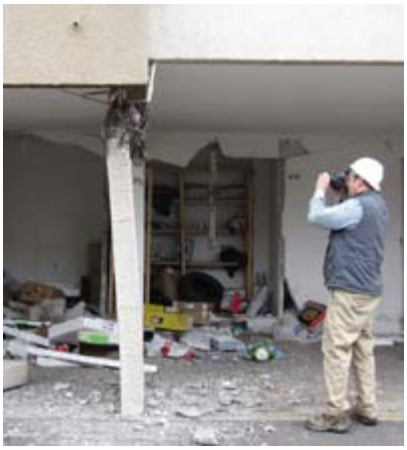
BFRL's programs are focused on five strategic measurement science goals:

- Net-Zero Energy, High-Performance Buildings
- Advancing Infrastructure Delivery
- Sustainable Infrastructure Materials
- Innovative Fire Protection
- Disaster-Resilient Structures and Communities

In addition, BFRL carries out major statutory responsibilities assigned to it by the Fire Prevention and Control Act (1974), the National Earthquake Hazards Reduction Program Reauthorization Act (1977, amended 2004), the National Windstorm Impact Reduction Act (2004), and the National Construction Safety Team Act (2002).

was conducted with fires starting in a day room area open to the dormitory corridor. The results of the two studies were published in *Impact of Sprinklers on the Fire Hazard in Dormitories: Sleeping Room Fire Experiments* (NIST Technical Note 1658) and *Impact of Sprinklers on the Fire hazard in Dormitories: Day Room Fire Experiments* (NISTIR 7120.) More information on the U.S. Fire Administrations College campus Fire Safety Program can be found at www.usfa.dhs.gov/citizens/college/.

NIST Engineers Serving on Chilean Quake Research Teams



BFRL researcher Jeff Dragovich in Chile. (Photo Credit: NIST)

Jay Harris, a research structural engineer at the National Institute of Standards and Technology (NIST), was recently deployed to Chile as a member of a team of experts documenting the effects of the Feb. 27, 2010, earthquake in that country. The Chilean quake measured 8.8 on the Richter scale, making it one of the most powerful earthquakes of the last 100 years.

The team on which Harris was deployed comes under the auspices of the American Society of Civil Engineers (ASCE) Structural Engineering Institute (SEI). ASCE SEI deployed a national team of structural engineering experts to Chile during the week of April 5-12 to examine commercial buildings and industrial facilities in key areas of Chile that were impacted by the earthquake. The key objective of the reconnaissance is to determine implications for ASCE's national building standards for the seismic design of new buildings and seismic evaluation and rehabilitation of existing buildings.

In addition to Harris's trip, NIST research structural engineer Jeff Dragovich traveled to Chile earlier in March as a member of a large multidisciplinary team of experts under the auspices of the Earthquake Engineering Research Institute's Learning from Earthquakes (LFE) program. LFE is supported by the National Science Foundation (NSF) as part of its contribution to the National Earthquake Hazards Reduction Program (NEHRP), the federal governments coordinated long-term nationwide program to reduce risks to life and property that result from earthquakes in the United States. NIST is the lead NEHRP agency, partnering with the Federal Emergency Management Agency (FEMA), NSF and the United States Geological Survey (USGS).

Harris' and Dragovich's observations in Chile will be used to inform NIST planning for future earthquake engineering research that supports NIST's role in NEHRP and will contribute to improvements in U.S. national model building code seismic provisions.

For more information, go to www.eeri.org/site/news/latest-news/860-learning-from-earthquakes-program-sending-team-to-chile.

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